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THE MEASUREMENT OF THE EFFICIENCY OF INSTRUCTION IN READING

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One of the leading educational problems of the present day is that of measuring the efficiency of schools. In the past it has been necessary to rely upon opinion in many matters relating to the progress of children in school. There have been no adequate units until recently with which to express educational products. For this reason, the results of educational processes often have been expressed in terms of mere conjecture, which has had small scientific value. An attempt has been made during the last few years, however, to establish standards and units by which scholastic efficiency and progress in educational attainment may be measured in a definite manner and to this end experimental and statistical methods have been applied to the measurement of educational results. Since a large part of the educational practice in the past has had no scientific foundation, the results of much of the teaching have been meager, and since there have been no adequate means of measuring the efficiency of instruction, it has been impossible to determine in any precise manner what real results were being secured. To a certain extent this condition still prevails, and on that account it may be said that one of the great needs in education at the present time is the establishment of units of measurement, standards of attainment, and reliable tests in each subject by which the value of different types of instruction may be scientifically and competently measured.

There is no subject in the school curriculum in which there is a greater need that tests be devised with which to measure the accomplishment of children than reading. It is the purpose in this article to describe a test planned for this purpose which has been used by the writer to measure reading ability in seven New Hampshire school systems. A description of the test, the method

of handling it, and the purpose for which it was designed are given in this article. The results of the test will be given in a future article. It was devised as an experiment to see what could be done in the way of measuring reading ability, and for the purpose of finding out how best it might be conducted. The division of educational investigation of the state educational department with the school system of the state as a laboratory is in charge of the writer and this investigation in connection with reading was undertaken as a part of the regular research work of the department.

The possibility of effectively measuring accomplishment on the part of children in school opens to the school administrator one of the most fruitful fields and one of the most promising lines of progress in the direction of the establishment of more scientific methods of teaching. With an effective means of measuring reading power it will be possible definitely to evaluate methods of teaching reading in terms of the ability of the children to read. Until this can be done the most satisfactory advance in the reconstruction of the method of instruction to secure a more efficient method will not be likely to be made. In order to attack this problem of the pedagogy of reading in a manner most favorable to progress, the method of approach must involve three distinct lines of investigation.

Reading is the greatest tool for thought-getting which an individual may have at his disposal. A comprehensive survey of the needs of the individual as a member of the social group must be made and those specific reading abilities which will function in the most serviceable way as a tool in the life of the individual must be determined. When the social needs of the individual in terms of reading power are set forth clearly in the form of certain specific reading abilities, we shall have a statement of the end to be attained by the educative process as far as this subject is concerned. This is the first great essential to progress in the right direction.

The psychology of reading has been a subject of study by a considerable group of investigators and there is at hand a respectable body of facts relating to the psychology and physiology of reading. Scientific investigation, the aim of which has been to

describe the act of reading, has yielded data which are of great value to the student of experimental pedagogy. From a study of all the known facts at hand in this field the school man is able to establish certain hypotheses in regard to the method of procedure in instruction. These hypotheses will be in the form of tentative principles of teaching. We may now proceed to teach reading in accordance with the body of principles thus established. But even when a survey has been made of every known fact there is no positive assurance that the methods derived and the resulting educational practice are valid. We must have, however, working hypotheses based upon the known laws of learning and on the nature of the mental processes in children, and the most fruitful source of such hypotheses, and about the only one of great scientific value is a study of child nature in all its aspects, for it is universally recognized that knowledge regarding the laws regnant in the physical organism and predominant in the mental life of the child can furnish the only valid foundation for methods of teaching. Studies in educational psychology and experimental pedagogy have been made in large numbers and the results of these studies throw great light on many problems of teaching, especially in indicating the lines along which the most efficient and economical learning is likely to take place. The scientific school man on the basis of the data at his command is able to develop an experimental technique of instruction in the several school subjects.

A third step is necessary in establishing a valid scientific pedagogy of reading. Before we can be assured that our method is in accordance with correct principles it must be evaluated in terms of the ability of the children to read. The results of the method must be measured and it must prove its validity. As the process of evaluation proceeds, elements of efficiency will be found and elements of weakness will be discovered. A process of selection by which the former are selected and retained and the latter eliminated will now ensue, until in due time a new pedagogy of reading will be evolved which will be in harmony with the laws of the most economical learning.

This, in brief, is the method which must be pursued in all school subjects to secure satisfactory advancement in the direction

of the evolution of better methods of instruction, which are so imperatively needed at the present time. The order of procedure must be: a consideration of the social needs of the individual, the formulation of an experimental technique of instruction, and the evaluation, by properly conceived tests, of the various elements which form a part of the instruction, with a constant reconstruction of method until the highest economy and efficiency are attained. The technique of teaching in every school subject must be subjected in this manner to scientific evaluation. This attitude toward problems of educational practice gives a large place to experimental pedagogy and the measurement of educational results. It is highly desirable that variations in the method of the instruction in primary reading be adopted and that systematic measurement of the results be made for the purpose of determining new elements of efficiency. This gradual rebuilding of educational practice is one of the important problems of the day as the great mass of significant facts regarding the mental processes of children and the nature of the learning process accumulates. The existence of this problem makes it imperative that a means of measuring educational products and of evaluating types of instruction be devised.

In determining reading efficiency three factors must be taken into consideration. In the first place, of two readers whose grasp of content is equally great, that reader who can read the larger amount in a given time has greater reading ability. The rate of reading, then, appears to be a very important factor. Again, of two people who can read the same amount in a given unit of time, that one whose grasp of content is greater is the better reader. In this case the reader who can reproduce the larger amount of what he has read and who can reproduce it more correctly is the more efficient. The whole question of reading efficiency reduces to this: the reader who can read the largest amount in a given unit of time, who can reproduce the largest proportion of what he has read, and who can reproduce it most correctly, is the best reader. The three things which must be accurately weighed in order to have a complete measure of reading power are: (1) rate of reading; (2) quantity of reproduction; and (3) quality of reproduction.

The reading tests prepared by the writer to determine the factors in efficient instruction in reading consisted of a printed selection for each of the grades which were tested of about a page and a half, so arranged as to have the form of the two pages of an open book when it lies before the child on the top of his desk. The two selections consisted of simple prose, easily within the comprehension of any child. The length of lines, the size of type, and the form of the page conformed to a correctly printed reading-book. At the time for the test the printed selections were given out by the teacher and placed face down on the top of each child's desk. The directions were then given and talked over until it was certain that every child understood them. Then at a signal from the teacher each child turned his paper over and began to read. At the end of a minute a second signal was given at which each child marked the word which he read last and turned his paper over. The children were now given paper and asked to write all they could remember of what they had read and for this all the time needed was given. When the directions were given the children were told that they would be asked to tell what they read but that it was desired that they read as much as they could and get the thought.

It was now possible to count the number of words which each child read and determine the rate of reading, which was expressed in words per second. Each child's written reproduction was carefully examined and the number of ideas reproduced of the total number read was determined and was expressed in the form of a percentage. For example, in the portion of the selection read by a given child there may have been forty-eight ideas and he may have reproduced twelve of those ideas. The amount reproduced of what he read was, therefore, 25 per cent. This was called quantity of reproduction. The printed selections were in a form especially adapted to the test. The sixth-grade test, for example, was chosen from a book of Indian stories and practically rewritten and put in a form which was convenient for carrying out the test. It was so arranged that the number of ideas in any portion of it could easily be determined. In ascertaining the number of ideas reproduced by each child, to get the measure of quantity, every

idea was counted which was in most respects complete and in general correctly stated, even though some of the less important details were lacking. The reproductions were examined a second time and only those ideas were counted which were entirely correct in every respect and of which every detail was reproduced, though not necessarily in the words of the original. This was called quality of reproduction. We have here the three factors in reading efficiency.

But a measure of these three aspects of reading ability taken separately will not prove satisfactory. One child may have a high reading rate, a high quantity of reproduction, and a low quality. A second child may have a low reading rate and quantity and quality may both be high. It may be difficult to determine which ranks the higher. For example, suppose the averages of one grade are:

Rate of reading, 2.16 words per second.
Quantity of reproduction, 47.62 per cent.
Quality of reproduction, 39.17 per cent.

Let the averages for another grade be:

Rate of reading, 3.19 words per second.
Quantity of reproduction, 31.11 per cent.
Quality of reproduction, 29.97 per cent.

It is difficult to say at a glance just how much more reading ability one has than the other. It is necessary that some unit of measurement be established by which all reading efficiency may be measured. Accordingly a convenient unit was established. The following statement is a definition of it. One unit of reading efficiency is a reading ability in which such a rate of reading in words per second is combined with such a power of reproduction that the product of the number representing the rate and the average of the numbers representing the percentages of quantity and quality is unity. A person who can read at the rate of 0.5 words per second and whose quantity of reproduction is 3 per cent and whose quality of reproduction is 1 per cent has 1 unit of reading efficiency. A reading rate of 0.25 words per second combined with a quantity of 5 per cent and a quality of 3 per cent would also

represent the same unit, as would many other variations of the three factors. Here is an entirely definite unit by which reading efficiency may be expressed adequately in a comprehensible form. There is, of course, no mathematical relation between these figures. This unit is adopted arbitrarily as a convenient means of expressing reading power in definite comparable units. Any child's reading efficiency may be found by taking the product of the number representing reading rate and the average of the numbers representing the quantity and quality of reproduction. In this computation the average of the percentages of quantity and quality, as, for example, 41.15 per cent, is regarded as the number 41.15 and is multiplied by the rate. If the rate in this case was 2.15 words per second, the number of reading units would be the product of these two, or 88.47.

Reading material of different degrees of difficulty will be found, however, and an individual who has the ability to read at a certain rate and reproduce a certain percentage of what he has read in one selection may not have the same reading rate and power of reproduction in connection with matter twice as hard. The unit of reading efficiency must be spoken of in connection with material of a certain degree of difficulty. For this reason a scale needs to be established for reading material which shall represent a considerable number of different grades from very easy to very difficult. When this has been done it will be possible to speak of a unit of reading power as the ability to read at a certain rate and recall a certain percentage of the ideas read, in connection with reading matter of a given degree of difficulty. When we have a scale of this kind it will be possible to establish standards of reading ability for each grade. Without the scale a school man may use in testing a school system prose of any grade of difficulty and it will be possible to measure growth in reading power in any given period, compare different schools in the same system and different types of teaching, and carry on various similar lines of investigation.

The reading tests were given in only the third and sixth grades and a comparatively small number of children was involved, for the reason previously stated, that the tests were given for the first

time as an experiment and it was more convenient to make the first applications of the method with small numbers of children. A little over four hundred children were tested and some fairly definite pedagogical conclusions seem to be warranted from the data, which will be presented in another article. In many of the best schools divisions in reading consist of twenty-five pupils or fewer and it will always be desirable to test small groups of this size and to compare these groups in one school with similar groups in other schools.

The Tables I and II give the results of the tests.

TABLE I
GRADE III

School	Rank	Rate of Reading in Words per Second	Quantity of Reproduction	Quality of Reproduction	Reading Efficiency in Reading Units
A.....	1	2.16	41.66	35.41	83.24
B.....	2	2.71	26.94	22.49	56.98
C.....	3	2.04	27.28	23.59	51.89
D.....	4	1.94	26.35	21.70	46.61
E.....	5	2.64	19.23	15.65	46.04
F.....	6	1.47	29.73	24.11	39.57
G.....	7	1.08	42.82	27.73	38.10
Average...	2.01	30.57	24.38	53.20

TABLE II
GRADE VI

School	Rank	Rate of Reading in Words per Second	Quantity of Reproduction	Quality of Reproduction	Reading Efficiency in Reading Units
A.....	1	3.42	37.77	30.12	116.26
E.....	2	3.40	28.44	22.63	86.82
B.....	3	2.74	32.17	25.05	78.39
F.....	4	3.14	23.87	18.30	66.21
C.....	5	3.19	26.31	13.60	63.66
G.....	6	3.35	20.90	15.12	60.33
D.....	7	2.95	22.15	17.66	58.72
Average...	3.17	27.37	20.36	75.77

The object of the tests was to solve a problem in the pedagogy of reading, i.e., to determine the factors of efficiency in instruction, and it is here that tests of this kind have great value. In each of the seven school systems in which the tests were given reading

is taught in a different way in certain respects, and the teaching was analyzed into its factors and an attempt made to locate those which produced rapid learning or lack of it. The object, in other words, was to test the validity of the various hypotheses on which the teaching was based. It is entirely possible, and, in fact, not difficult, to analyze the teaching of reading in any given school into its constituent elements. For example, the following is the analysis of the teaching in one school in which the tests were given:

1. The teaching of words as wholes, from the beginning, by associating the visual form vividly with the appropriate object, idea, or experience.

2. Extensive quick-perception reading of sentences from the blackboard throughout the first year.

3. Especial emphasis on concentration upon the thought rather than upon words in all the lower grades.

4. Entire absence of phonetic drill in the two lowest grades.

5. Extensive quick-perception drill with perception cards on words, phrases, and sentences as wholes in the lower grades.

6. Class reading entirely at sight.

7. Number of books read per year entirely at sight in class in first six grades as follows: first grade, 7; second, 21; third, 17; fourth, 18; fifth, 15; sixth, 16.

8. Average number of books read per year for silent reading outside of class in the five years above the first grade as follows: second grade, 19; third, 39; fourth, 75; fifth, 61; sixth, 62.

9. A large amount of oral reproduction in the pupil's own words of the thought of what is read. After several pages have been read rapidly at sight in class, various pupils are called upon to reproduce the thought without further reading or study. Practice in rapid silent reading, followed immediately by oral reproduction.

10. In the third grade, beginning about the fourth month, enough phonic analysis of words as they are met in their functional relations in sentences to give the pupils a mastery of the phonic difficulties of the language.

Here are ten entirely definite and tangible factors which are the characteristic features of the instruction in primary reading in this school. The teaching in all of the schools tested has been

analyzed in this manner and the predominant features set forth. By thus analyzing the teaching into its main constituent factors in a considerable number of school systems in which the elements show important variations and by adequately measuring the products of the teaching, the pedagogy of reading can be reduced to its lowest terms and the factors of efficiency accurately determined. For example, to test the value of phonetic drill in teaching, a school system was selected to compare with that mentioned above in which the method of instruction was practically identical, with the exception that a considerable use was made of phonetic drill in the lower grades. In another school system the class reading was all prepared work, i.e., the lessons were read over several times before being read in class. After the factors entering into the instruction in reading in any school have been set forth, the resultant facts on the side of rate of reading, quantity and quality of reproduction, and number of units of reading efficiency may be represented in the form of mathematical expressions and also pictured to the eye by means of graphic curves, surfaces of frequency, and in other similar ways.

Widely different results in the three factors in reading efficiency were found as the products of the different types of teaching, and this is not surprising in view of the varying combinations of conditions which are possible. The rate of reading may be high or low and the quantity of reproduction may be large or small, with a similar variation in quality. As typical examples of what may be found we have the following: Rate may be high and combined with a large quantity and a low quality of reproduction. In another case, the same reading rate may go with a small quantity of reproduction and a quality nearly equal to the quantity. Again, rate may be low and quantity may be large and quality equal to quantity.

Another consideration which has a significant bearing on the evaluation of the method of instruction is that of the correlation of reading rate and power of reproduction. Correlation may be of three kinds: indifferent or positive or negative. Positive correlation exists when power of reproduction increases with reading rate and is complete correlation when it increases in direct proportion

to reading rate. Negative correlation exists when power of reproduction decreases as reading rate increases. When reproduction remains the same regardless of increase or decrease in the rate of reading, correlation is said to be indifferent. These factors may be combined in various ways, of which the following are typical examples: (1) low reading rate, percentage of reproduction large, negative correlation; (2) high reading rate, percentage of reproduction small, negative correlation; (3) high reading rate, percentage of reproduction large, positive correlation. Correlation may be of varying degrees, both positive and negative. It is self-evident that the type of teaching which produces the highest reading rate combined with the largest quantity and the highest quality of reproduction and positive correlation is the most efficient. This means that the group of pupils who are the most rapid readers at the upper end of the curve reproduce a larger percentage of the ideas read. Indifferent correlation indicates that the more rapid readers get equally as great a percentage of the thought as the slower readers, and since they read a larger amount their reading ability is proportionately greater. In negative correlation the more rapid readers reproduce a smaller percentage of the ideas read.

Figs. 1 and 2 are given to show the method of indicating correlation or lack of it. In this particular grade the condition is apparent at a glance. In the first place, reading rate is high and shows that word pronunciation has been mastered. But, on the other hand, the actual quantity of reproduction is small and there is no marked positive correlation of reading rate and quantity of reproduction. Quality of reproduction in this grade also falls a considerable distance below quantity in most cases. In other words, it can be seen at a glance that this is the product of a poor type of teaching, everything else being equal. It is entirely evident that these children are the kind so often seen who can read readily as far as mere word pronunciation goes but who do not apperceive, assimilate, and retain the content of what is read in anything like an efficient manner. When it is remembered that reading efficiency is made up of three factors it will be seen that the deficiency of this type of reading on the side of reproduction more than offsets the

high rate of reading. Had the reproduction curve been a good deal higher or had there been a gradual rise of the curve showing that assimilation was functioning efficiently, this would have been the product of good teaching, for the high reading rate enabled the pupils to read a large amount in a given unit of time.

Reading is about the most deceptive subject in the entire school curriculum and one in which mere opinion regarding efficiency has the least value. The writer recently visited a school in which the reading appeared to be highly efficient. The children could

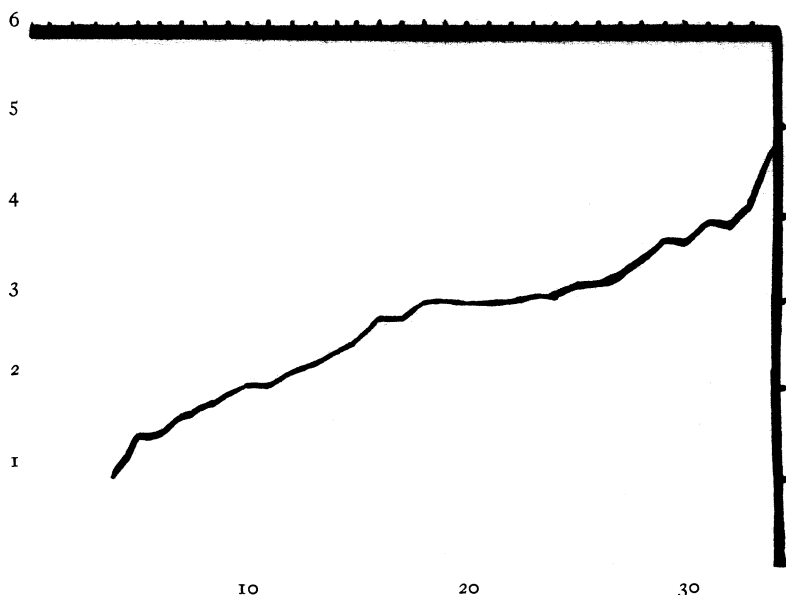


FIG. 1.—Curve representing the rate of reading in a sixth grade of 31 pupils. The scale along the base of the figure represents the number of children in the grade. The scale at the left shows the rate of reading in words per second. The papers were arranged in order of rate of reading.

stand and read a page with the utmost *apparent* ease and fluency and the casual observer would have said that it was reading of the highest competency. Word-pronunciation had been splendidly mastered. It is entirely possible and often happens that reading of this kind is in reality of low grade. Reading is essentially an apperceptive and assimilative process and when these processes

do not function actively reading is not good, although mere word-pronunciation may be perfect. In such reading as this the rate will be high, but it often happens that combined with a high rate of reading are a small quantity of reproduction, a low quality, and negative correlation. Since reading efficiency is a product of

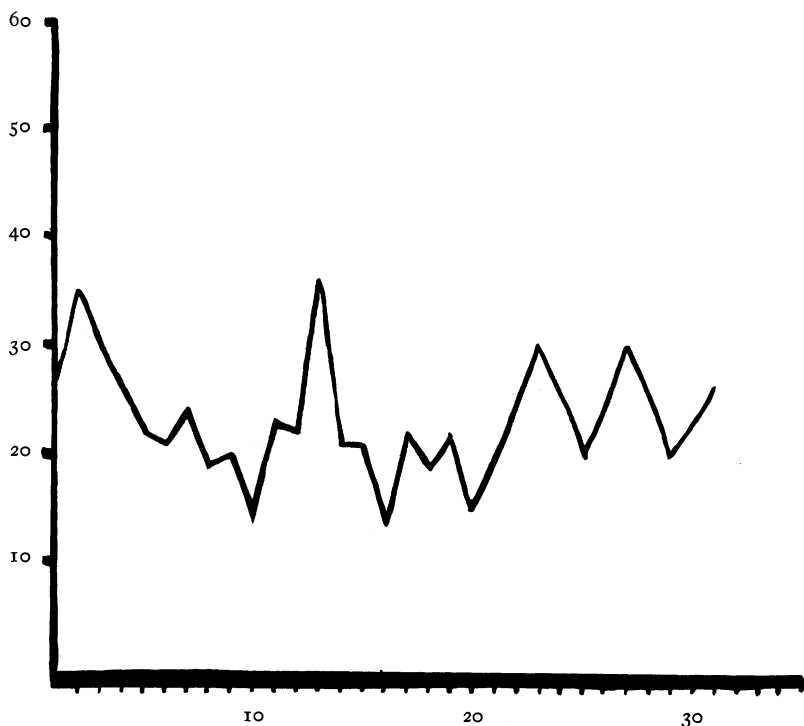


FIG. 2—Curve representing quantity of reproduction of the same children as in Fig. 1, and in the same order. Fig. 1 and Fig. 2 show the correlation of quantity of reproduction and reading rate in this grade. The scale at the left shows the percentage of quantity of reproduction.

several factors, reading of this kind is mediocre in quality. It cannot be pointed out too often that reading is more than mere word-pronunciation. It is feared that some of our prevailing methods of instruction in primary reading are faulty for the reason that undue emphasis is placed on too rapid and too complete mastery of the difficulties of word-pronunciation in the earliest

stages of reading at the expense of apperceptive and assimilative activities and that this type of teaching produces a pronounced word-consciousness and a confirmed habit of reading words instead of thoughts from the printed page which the pupil never completely outgrows and which proves a real hindrance to real thought-getting in later stages of his reading.

It seems clear that by the kind of a test under discussion the factors in reading efficiency may be determined accurately and the various reading methods efficiently evaluated. The data which have grown out of these tests suggest emphatically that the prevailing pedagogy of primary reading is in need of thoroughgoing reconstruction in important particulars. Much of our educational practice in this field is based upon sheer tradition, has insufficient scientific foundation, and fails to give good account of itself under the stress of the test of scientific measurement and evaluation. A new and more correct pedagogy of primary reading must be constructed, based upon the known laws of the learning process. Never can the most satisfactory technique of instruction in this particular be developed until the laws of efficient and economical learning are known and methods of instruction based on these laws. The large question here is: How do we most efficiently and economically perceive, apperceive, and assimilate the printed sentence? The problem involved in learning to read opens the whole field of the psychology and physiology of the reading act and involves the whole question of the psychology of visual perception as related to the printed sentence. A close scientific analysis of all the known facts entering into the complete description of the reading act and the construction of a pedagogy of primary reading based on the facts, followed by a rigid evaluation of the method so established in terms of the ability of the children to read and the gradual determining, selection, retention, and elaboration of elements of efficiency in the instruction and the elimination of elements of weakness until the most effective method possible has been formulated is the only mode of attacking a pedagogical problem which insures the most rapid progress.